APPENDIX B4: Shell Height/Meat Weight Relationships

New shell height/meat weight data was collected on the annual NMFS sea scallop survey during 2001-2006. This appendix will present and analyze these data.

Methods

Sea scallops (averaging about 6 per station) were selected for analysis on roughly half of all stations (511 stations in the Mid-Atlantic, 592 stations on Georges Bank). The scallops were measured to the nearest millimeter, carefully shucked, excess water was removed from the meat, and the meat was weighed to the nearest gram. Data was also collected in 2003, but there was partial data loss when the data was transferred from ship to shore, so these data will not be used. In 2004-2006, whole and gonad weights were also recorded, but these data will not be presented here. The data here was separated into two regions (Mid-Atlantic and Georges Bank); further separation into subareas is possible, but will not be presented here.

Preliminary analysis indicated a residual pattern for those scallops with shell height less than 70 mm due to the small weights of these scallops (1-3 g) combined with the fact that meat weight could only be measured to the nearest gram. For this reason, the analysis was restricted to scallops that are at least 70 mm shell height. Scallops less than this height are below commercial size and thus their meat weight has no influence on CASA model calculations.

A generalized linear mixed-effects (GLMM) model was used to fit the equations

$$W = \exp(\alpha + \beta \ln(L)) \qquad \text{(A4-1)}$$

and

$$W = \exp(\alpha + \beta \ln(L) + \gamma \ln(D)), \qquad \text{(A4-2)}$$

where W is meat weight (grams), L is shell height (mm), and D is depth (meters), to the data. The GLMM used a gamma likelihood with a log link, appropriate for data (such as these) with "constant CV" error (McCullagh and Nelder 1989). This method avoids log-transforming the response variable (meat weight) that can lead to biased estimates when back-transformed. Because samples collected at the same station may be more similar than those from other stations, "station" was used as a random effect, and this random effect was weighted by the total number of scallops caught on that station so that stations at high abundances would be appropriately represented. The results were compared to those using a simple log-log regression and a GLM with just fixed effects. Both of these gave nearly identical results after applying a bias correction to the log-log regression, and differed only slightly from the GLMM presented here. All data analysis was conducted using the R statistical program (v2.3.1), with the lme4 mixed-effects package.

Results

Mid-Atlantic

A total of 2945 observations were sampled from 511 stations (Figure 1). Parameters (Table App4-1) were well estimated with no evidence of a residual pattern (Table 2, Figure 2).

Predictions from the new estimates are similar to most previous estimates, with the exception of Lai and Helser (2004) (Figure 3). Compared to the estimates used in previous assessments, the new estimates predict slightly heavier meats at small shell heights, but lighter meats at very large shell heights, but these differences are very small. The relationship that includes a depth effect indicates that sea scallops have considerably heavier meats at shallower depths (Figure 4).

Georges Bank

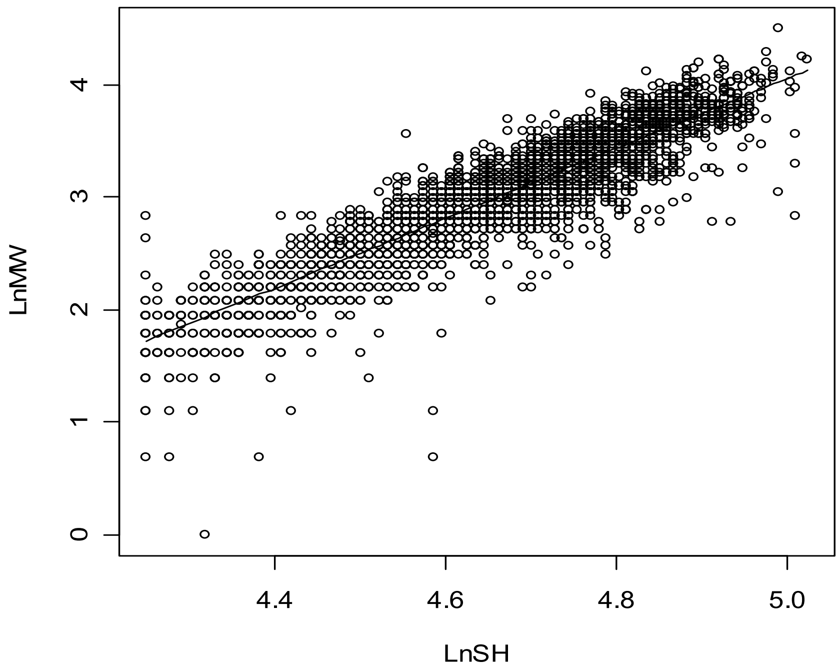
Based on 3824 scallops at 592 stations, model fits appeared good with little or no residual pattern (Figures 5-6). Parameters reasonably precise (Tables 1-2), and, as was the case for the Mid-Atlantic relationships, predict slightly greater meat weights at small shell heights, and slightly lower meat weights at large shell heights than does the relationship used in the previous two assessments (Figure 7). Predictions from the new relationship fall about in the middle of other estimates. Meat weights were substantially greater at shallower depths (Figure 8).

APPENDIX B4 Table 1. New shell height/meat weight parameters, with those from other studies for comparisons

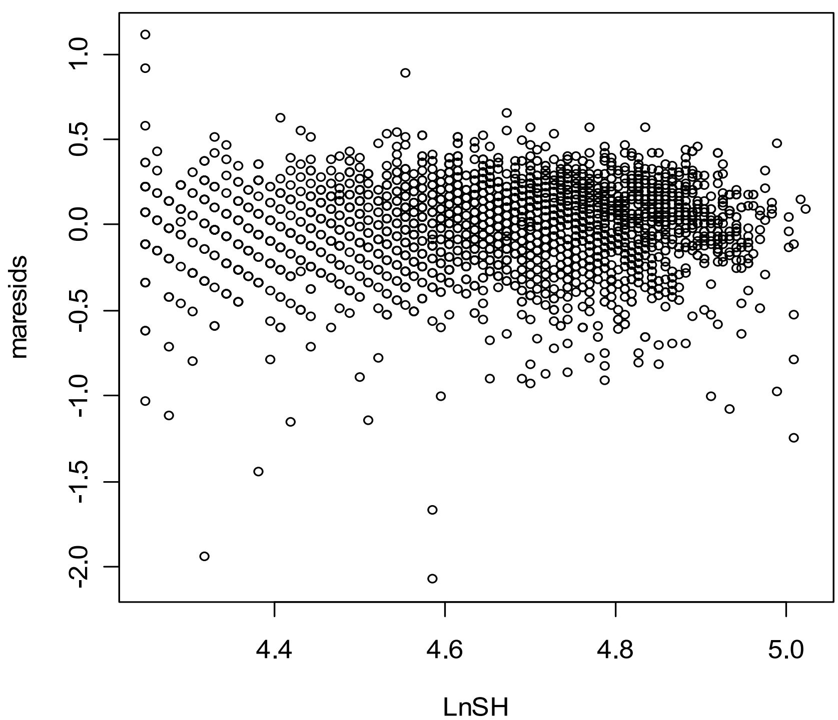
	α	β	γ
Mid-Atlantic Bight			
Haynes (1966)	-11.0851	3.0431	
Serchuk & Rak (1983)	-12.1628	3.2539	
NEFSC (2001)	-12.2484	3.2641	
Lai and Helser (2004)	-12.3405	3.2754	
New	-12.01	3.22	
New with depth effect	-9.18	3.18	-0.65
Georges Bank			
Haynes (1966)	-10.8421	2.9490	
Serchuk & Rak (1983)	-11.7656	3.1693	
NEFSC (2001)	-11.6038	3.1221	
Lai and Helser (2004)	-11.4403	3.0734	
New	-10.70	2.94	
New with depth effect	-8.62	2.95	-0.51

APPENDIX B4 Table 2. Standard errors for the new parameter estimates

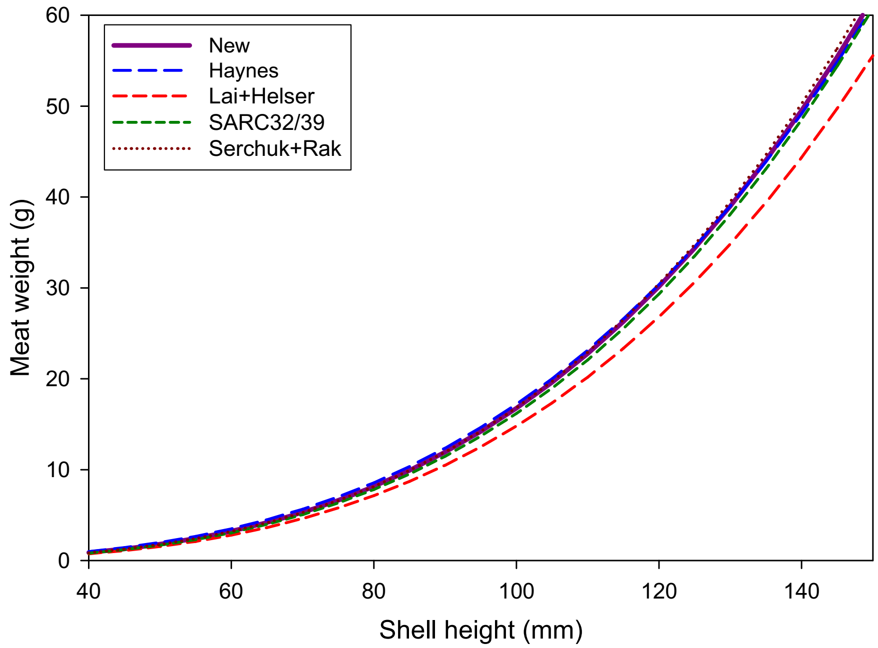
	α	β	γ
Mid-Atlantic Bight			
New	0.15	0.05	
New with depth effect	0.39	0.05	0.08
Georges Bank			
New	0.27	0.06	
New with depth effect	0.17	0.05	0.05



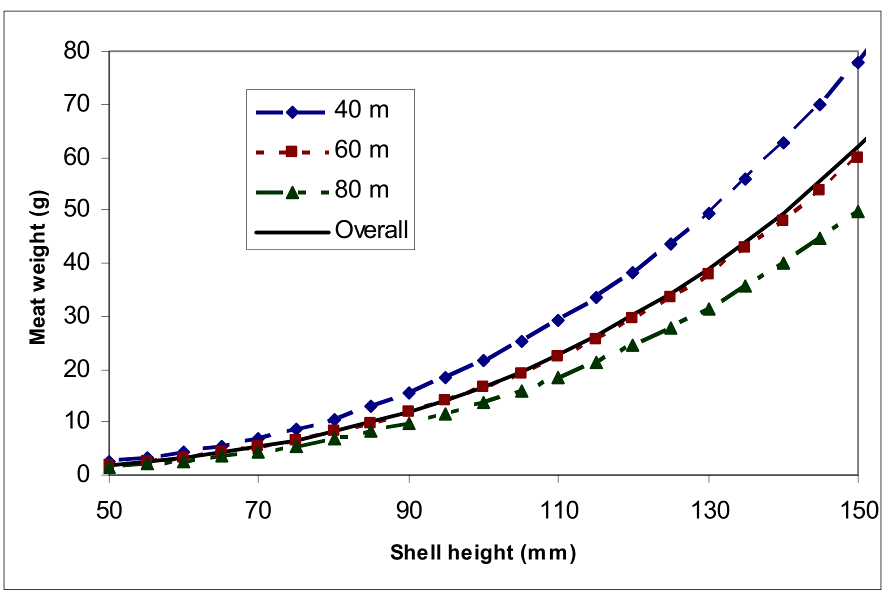
APPENDIX B4 Figure 1. Mid-Atlantic shell height/meat weight data



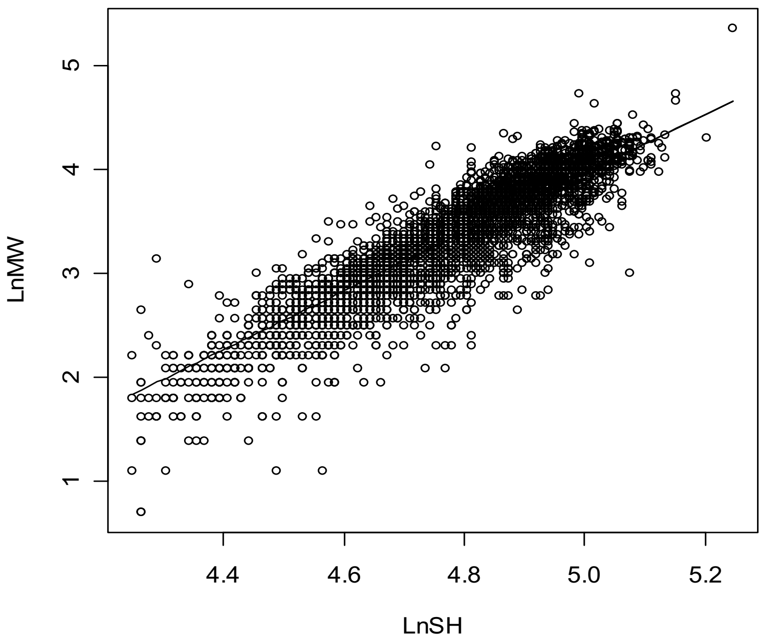
APPENDIX B4 Figure 2. Residual plot of Mid-Atlantic SH/MW data



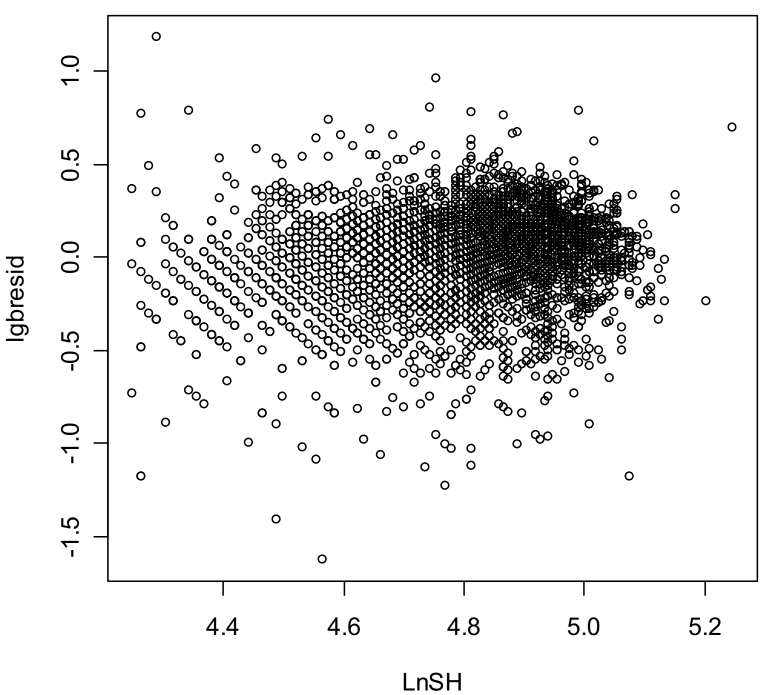
APPENDIX B4 Figure 3. Comparison of shell height/meat weight in the Mid-Atlantic



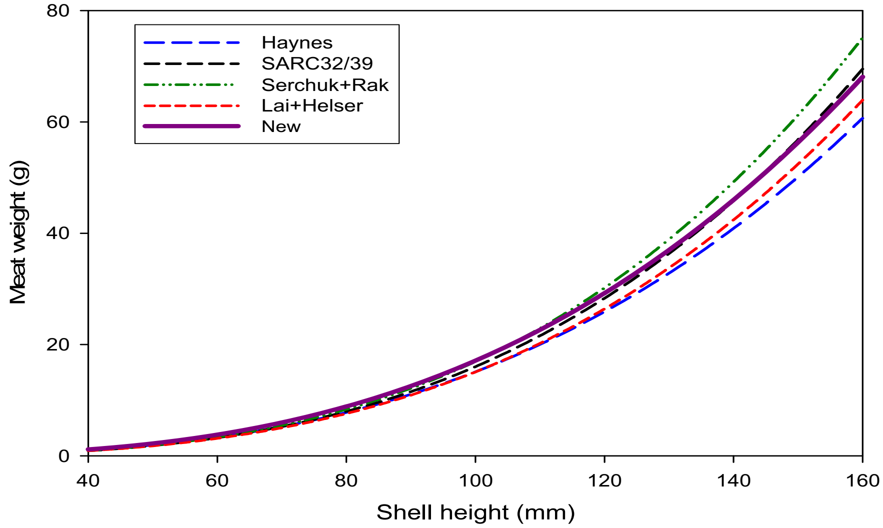
APPENDIX B4 Figure 4. Shell height/meat weight relationships at relationships 40, 60, and 80 m depth, and overall



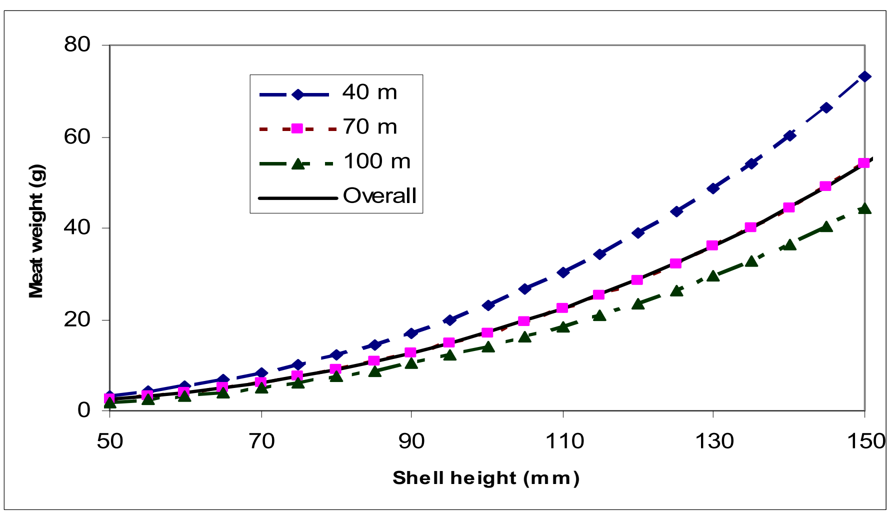
APPENDIX B4 Figure 5. Georges Bank shell height/meat weight data



APPENDIX B4 Figure 6. Residual plot of Georges Bank SH/MW data



APPENDIX B4 Figure 7. Comparison of SH/MW relationships in Georges Bank



APPENDIX B4 Figure 8. Georges Bank SH/MW relationships at 40, 70, 100 m depth and overall